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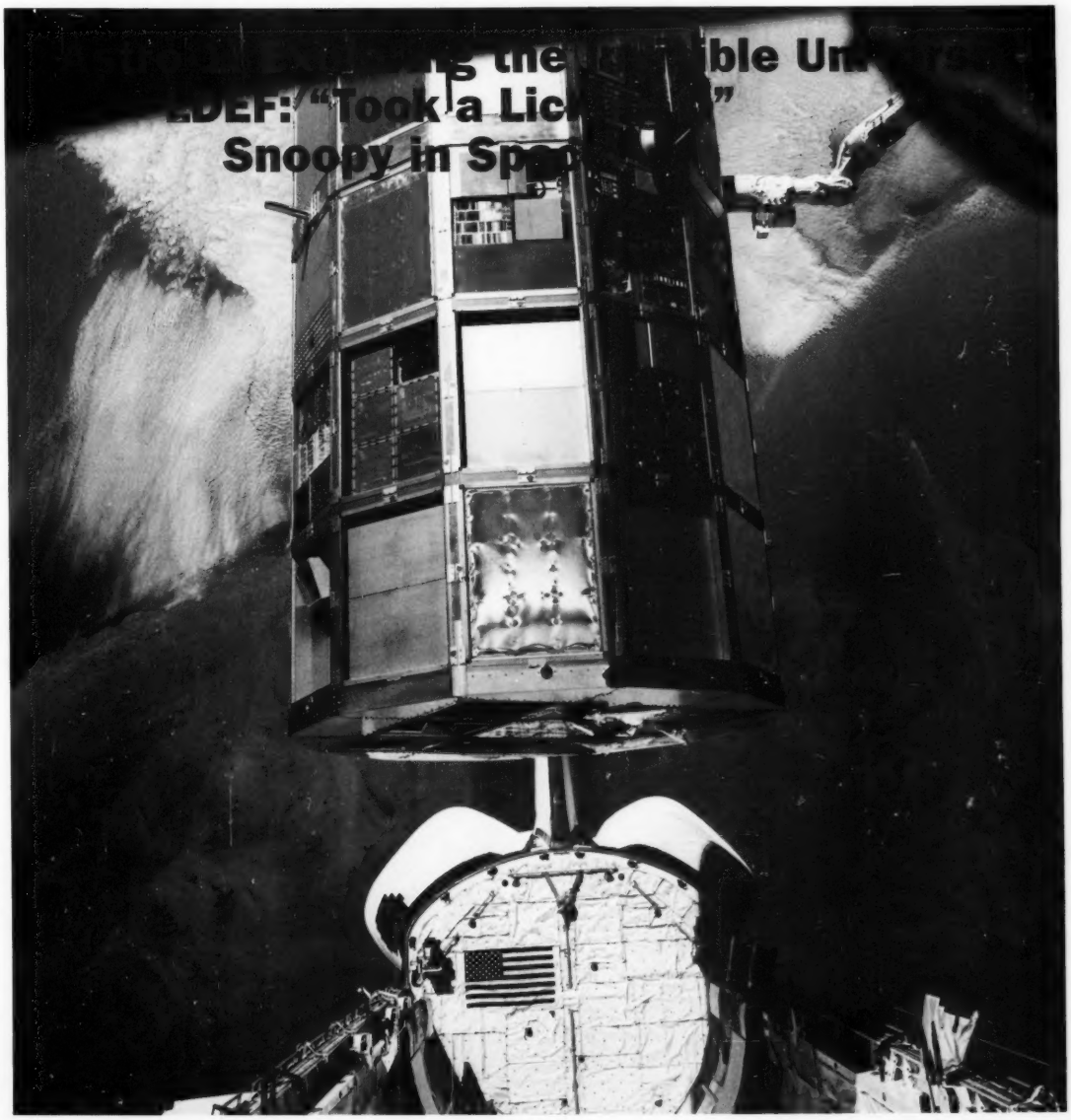

THIS ISSUE

Imagine Pasadena's Tournament of Roses parade on television in black and white, or Old Glory as black, white and gray instead of red, white and blue and you have an idea of the limitations of looking at the universe in only the spectrum that is visible to human eyes. Astro-1, a package of telescopes and instruments designed to open our eyes to the ultraviolet and X-ray view of the universe, is due to ride into space aboard the Space Shuttle Columbia in early May. *NASA Activities* provides a peek at the mission.

NASA Law–not a new nighttime techno soap–but an "Inside NASA" article on the Office of the General Counsel. The column examines this important service to the agency.

Flying faster farther is the subject of recently published reports commissioned by NASA. The Boeing/Douglas reports on environmental compatibility, marketability and public acceptance of a next-generation supersonic commercial airliner are reviewed in this issue.

Back home again, LDEF, the Long Duration Exposure Facility is providing a look at the effects of long term space travel. See page 15.

"Good grief, Charley Brown, how did Snoopy ever come to NASA?" "Snoopy in Space" chronicles the lovable Charles Schultz mascot and his support of NASA's Manned Flight Awareness program and America's journey to the moon.

Next Issue:
A Life Science Return to Space

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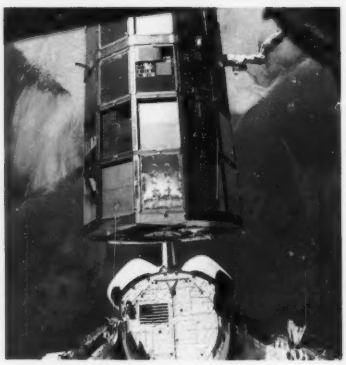

About the Cover

The Long Duration Exposure Facility (LDEF) appears over the cargo bay of the STS-32 Space Shuttle Columbia prior to capture.

LDEF's nearly six years in space left it somewhat worn, but millions of young students eagerly awaited its cargo of 12-million space veteran tomato seeds for planting and study. See page 15 for the LDEF story.

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OFFICIAL COMMENT

Vice President Emphasizes White House Space Commitment

Vice President Dan Quayle's visit earlier this year with NASA senior management gave the agency a resounding vote of confidence.

Speaking at an informal luncheon at NASA Headquarters, Washington, D.C., the Vice President emphasized that the White House "is committed to making space a priority."

Space Priority

The Vice President told NASA officials that their immediate challenge is to "reignite interest and energy in the space program beyond the Beltway." He characterized the civil space program as being of "critical importance" to the nation.

Quayle is chairman of the National Space Council, which is charged with overseeing the President's national space policy and coordinating interagency space issues. He met with NASA Administrator Richard H. Truly, Deputy Administrator J. R. Thompson, Jr. and the associate administrators who oversee the agency's various programs.

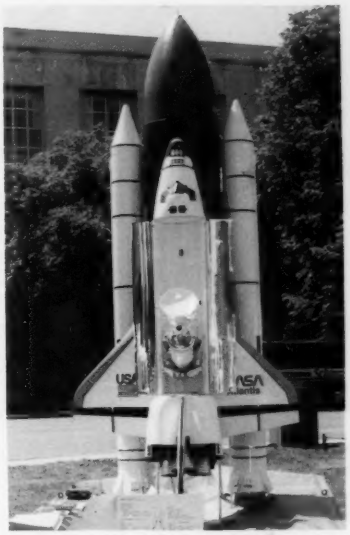
Vice President Dan Quayle (center), chairman of the National Space Council, discusses the civil space program with (from left) Mark Albrecht, executive director of the Space Council, J.R. Thompson, Jr., NASA deputy administrator, and Richard H. Truly, NASA administrator.

Technological Competitiveness

The Vice President discussed the value of new technology that flows from the space program and how it makes the United States more competitive in the world market. He also spoke at length on the link between NASA and education and, in particular, how the space program can inspire students to study science and math.

Unquantifiable Benefits

The Administration's budget request was a 23 percent funding increase for NASA for FY 1991, the largest increase for any major agency. The President's budget message said that, "The exploration of space has benefits for the United States that go far beyond the quantifiable. There are specific payoffs in the form of new materials, technological discoveries and microgravity research. But no price can be put on the lifting of the spirit of people everywhere ... And no quantitative measure of any kind can capture the benefit of expanding human horizons, human dreams and the human domain."■



Marshall Space Flight Center scale Space Shuttle model will grace the National Mall to honor public employees.

Pride in Public Service

America's public employees are among the finest and most productive civil service employees in the world. To celebrate and honor those who dedicate their lives and careers to public service, the Public Employees Roundtable, the President's Council on Management Improvement and the District of Columbia Government are all sponsoring Public Service Recognition week, May 7—13, 1990.

To celebrate this week, NASA and several Federal, D.C. Government and public agencies are recognizing public employees by providing exhibits and music on the National Mall for "Pride in Public Service" from May 10 through May 12.

NASA's exhibit will be a 1/15th scale model of the Space Shuttle, provided by the Marshall Space Flight Center, Huntsville, Alabama.■

INSIDE NASA

NASA Law: Office of the General Counsel

The Office of General Counsel (Code G) provides legal advice and assistance to all organizational components of NASA and performs other functions assigned or inherent to the Office of General Counsel.

The NASA Office of General Counsel is headed by the General Counsel, Edward Frankle. There are approximately 25 attorneys in the Headquarters Office of General Counsel. In addition, each field center has an Office of Chief Counsel.

The Office of General Counsel is a service organization, providing assistance to each office at Headquarters, just as a law firm would provide assistance to a client. The type of assistance provided often depends on the stage at which the General Counsel's office gets involved. For example, during the planning stage of an event or program, the Office can assist program offices in anticipating and avoiding problems before they develop. However, the Office will always assist a client confronted with an issue requiring legal guidance.

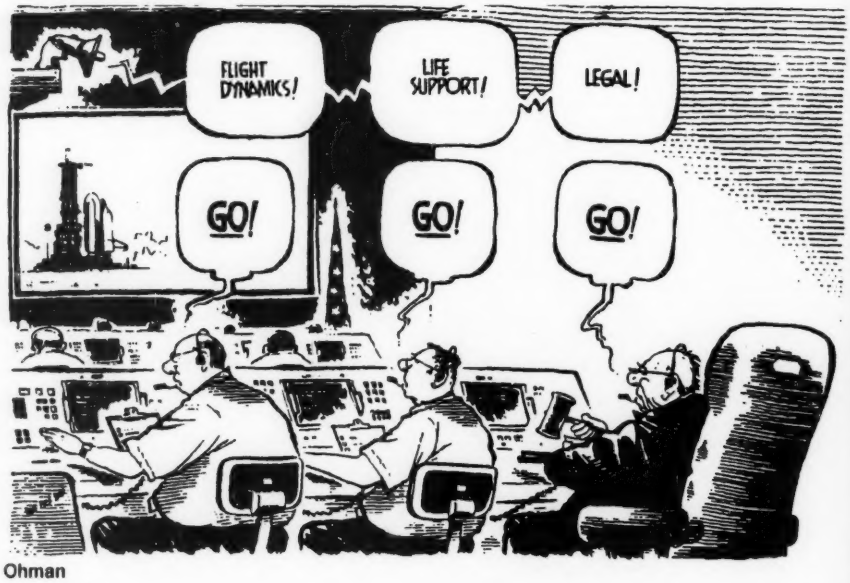
The Office of General Counsel is currently divided into three broad areas of law, each of which is headed by an Associate General Counsel. The three areas are Intellectual Property, Contracts, and General Law.

Intellectual Property

Intellectual property law (Code GP) encompasses patents, licensing, trademarks, copyrights, and data rights. In its most general sense, intellectual property law governs how NASA either protects against or assists in the transfer of technical information, depending on the Government's best interests. For instance, intellectual property lawyers assist NASA in protecting its and its employees' proprietary interests in inventions produced with the Government's funds. This area of law also protects against the disclosure of trade secret information delivered to NASA by contractors. Finally, intellectual property law can be used to encourage the transfer of NASA technology to the scientific and industrial communities. The Associate General Counsel for Intellectual Property is Robert Kempf.

Contracts

The contract law section of the Office of General Counsel (Code GK) is responsible for the Agency's compliance with all procurement statutory and regulatory requirements, support in the preparation and review of procurement plans, requests for proposals, research announcements, grants, contracts, suspension and debarment of contractor decisions, and many other procurement issues. The Associate General Counsel (Contracts) David Forbes, and his staff are also responsible for legal representation on the Defense Acquisition Regulatory (DAR) Council and at Source Evaluation Board (SEB) proceedings. This section of the Office also defends the Agency in procurement litigation before the NASA Board of Contract Appeals, General



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Accounting Office, and General Services Board of Contract Appeals. Moreover, they provide legal support to the Department of Justice representing NASA before the United States District Courts, the United States Claims Court, and Court of Appeals for the Federal Circuit.

General Law

The General Law section (Code GG), headed by Associate General Counsel, George Reese, is responsible for a variety of different areas, including environmental law, equal employment opportunity proceedings, agency participation on the United Nations Committee on the Peaceful Uses of Outer Space, employee compensation claims, tort claims, implementation of legislation concerning employee drug testing, personnel and ethics issues and regulations, and Space Act Agreements. Basically, Code GG covers any area of law except for intellectual property and procurement.

Commercialization of Space

The Office of General Counsel also supports efforts to "commercialize" space, consistent with heightened Congressional interest. The Office assists the Offices of Commercialization and Space Flight in drafting launch service agreements, Center for Commercial Development of Space flight agreements, joint endeavor agreements, and space systems development agreements. This effort is supported by attorneys lead by Assistant General Counsel June Edwards.

The areas of responsibility of the Office of General Counsel are as varied as the programs of NASA. But also, just as each Code has its own area of expertise and focus, so too does the Office of General Counsel, offering its knowledge of the law to further the mission of NASA. ■

HITCHING TO HOUSTON? — On Rogers Dry Lake, the STS-36 Atlantis crew gives the "thumbs up" signal on a DOD mission well done. From left to right: mission specialists Pierre J. Thuot, David C. Hilmers, pilot John H. Casper, mission commander John O. Creighton and mission specialist Richard Mullane. While the STS-36 crew returned to Houston, the Space Shuttle Atlantis was prepared for ferry back to Kennedy Space Center at NASA's Ames-Dryden Flight Research Facility.

Possible Arctic Ozone Loss

Chemical processes that lead to ozone depletion in the Antarctic are present in the far Northern Hemisphere, and some regions of the Arctic stratosphere may have suffered ozone losses up to 17 percent during the winter of 1988-89, results of the 1989 Airborne Arctic Stratospheric Expedition (AASE) indicate.

At the conclusion of the mission in February, AASE scientists released a statement that "no unequivocal signature of photochemical loss of Arctic ozone was identified before the end of this mission. However, by the end of this mission a considerable portion of the vortex air was primed for destruction."

After almost a year of analysis had refined that conclusion, several investigators, using different analytical methods, reported the Arctic ozone losses. For example, a team led by Dr. Edward Browell of NASA's Langley Research Center, Hampton, Va., used a laser-based technique similar to radar to measure ozone distribution and observed depletions of up to 17 percent at some altitudes.

A group led by Dr. Mark Schoeberl of Goddard Space Flight Center, Greenbelt, Md., inferred average photochemical ozone losses of 0.44 percent per day over the mission at altitudes above approximately 12 miles.

Chemical analyses showed increased levels of active chlorine and lower-than-expected levels of nitrogen oxides in the atmosphere. In their prologue, Richard Turco of UCLA, Alan Plumb of MIT and Estelle Condon of NASA's Ames Research Center, Mountain View, Calif., wrote that these measurements indicate that chemically "the Arctic stratosphere is primed for an ozone hole." Meteorological conditions, however, were found to be unsuitable for the development of an Arctic ozone hole similar to the one observed over the Antarctic. ■

AGENCY HIGHLIGHTS

NASA Debuts New Education Facility

A new NASA education project was launched by NASA Administrator Richard H. Truly during ceremonies at Washington, D.C.'s Spingarn Complex. The first of what NASA hopes will become a fleet of tractor-trailer mounted mobile teacher resource centers opened as D.C. teachers experienced hands-on activities in and toured the 22-ton facility.

The mobile teacher resource center is part of a larger NASA education initiative, project LASER, "Learning About Science, Engineering and Research."

LASER is outfitted with six work stations, each serving two teachers concurrently. Each work station is equipped with a computer, providing access to "NASA Spacelink," an electronic information system with a broad range of information and educational materials of value to teachers of grades K-12.

The work stations also include a videotape recorder and monitoring systems so teachers can copy from a large library of NASA educational videotapes. In a separate common-use work station is a large library of lesson plans, activities and slides. The trailer also contains photocopy and photographic equipment that will allow teachers to copy these materials for later use in the classroom.

This pilot program has been developed by NASA's Marshall Space Flight Center, Huntsville, Ala., with corporate sponsorship. ■

District of Columbia teachers tour LASER mobile teacher resource center.

New Carbon Brakes Stop Shuttle

Newly designed carbon brakes on the orbiter Discovery's main landing gear wheels brought the Hubble deployment mission to a safe conclusion and a sure stop on Rogers Dry Lake, Edwards, Calif.

Discovery was selected to be the first orbiter to have the new brakes installed because the instrumentation necessary to evaluate the performance of the brakes was already in place.

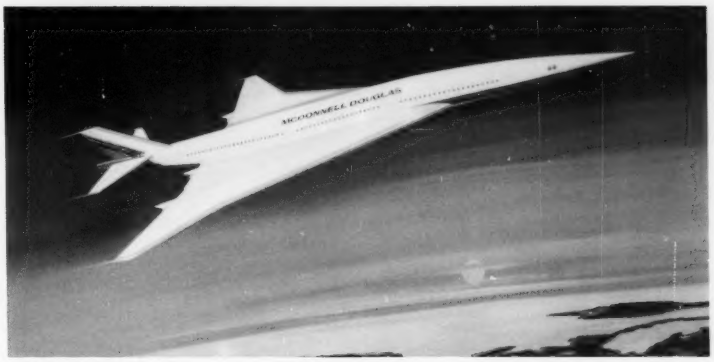
Instrumentation consists of strain gauges and accelerometers.

Following successful landing tests, the carbon brakes will eventually replace the older beryllium brakes on all Shuttle orbiters. The installation of carbon brakes is one of a number of steps necessary to land orbiters again at Kennedy Space Center.

The brakes were tested on the Shuttle for the first time under actual operating conditions during Discovery's landing at Edwards, following completion of the STS-31 mission. The initial test was to involve low energy braking on the desert runway. Braking power will be increased during subsequent landings on Edward's concrete runway. Following landings, engineers will remove the brakes and send them to the designer, B.F. Goodrich, Troy, Ohio, for analysis.

The pure carbon brakes are similar in many respects to the older carbon-lined beryllium brakes now used, but they differ in performance and life expectancy. Carbon brakes are able to withstand longer distance braking and higher braking temperatures of up to 2100 degrees F. The nominal temperature operating range is 1200 degrees F. Under normal braking operations, the carbon brakes can be used for 20 or more landings before replacement is needed. ■

High-Speed Transport Acceptance Linked to Technology Advancements



A McDonnell Douglas conceptual design for a Mach 3.2 supersonic transport would carry about 300 passengers 7,500 miles.

Results from the first 2 years of high-speed civil transport studies suggest that technological advances will determine the environmental compatibility, marketability and public acceptance of a next-generation supersonic commercial airliner.

Boeing Commercial Airplanes, Seattle, and Douglas Aircraft Co., Long Beach, Calif., recently published reports covering the first phase of studies commissioned by NASA. Based on projections for significant increases in transoceanic air travel, both companies concluded that there will be a market for commercial transports flying at two to three times the speed of sound (1350-2000 mph) between the years 2000 and 2015. According to the studies, transpacific air travel should increase four-fold by the year 2000, while transatlantic passenger trips are expected to double.

Trip times aboard a high-speed civil transport would shrink dramatically compared to flights on today's wide-bodied subsonic airliners. A trip from Los Angeles to Tokyo, for example, would be reduced from just over 10 hours to a little over 4 hours. A next-generation supersonic airliner could carry up to three times the passenger load of the current Anglo-French Concorde at less than one-seventh the cost per passenger mile and with about twice the Concorde's range.

The Boeing and Douglas studies determined that substantial demand for an advanced supersonic transport will materialize only if the aircraft meets allowable standards of airport noise, has no harmful effects on the atmosphere and is economically competitive with future long-haul subsonic airliners. The plane's economic practicality would be enhanced if it meets acceptable overland sonic boom noise levels.

The reports pointed out that technology to build a high-speed civil transport satisfying these requirements is not yet available. They identified significant advances that should be possible by the early 21st century, however, such as variable-cycle engines, newer composite and metallic materials combined with new structural designs, supersonic laminar air flow and fully integrated flight and engine controls. These technology developments would permit supersonic airliners to be more efficient, in turn allowing supersonic fares to compete with subsonic fares.

Each company focused on a different class of aircraft.

Douglas studied a Mach 3.2 (approx. 2,150 mph) design sized to carry approximately 300 passengers a distance of 7,500 statute miles. Boeing's Mach 2.4 (approx. 1,600 mph) concept, which could be developed more quickly, was

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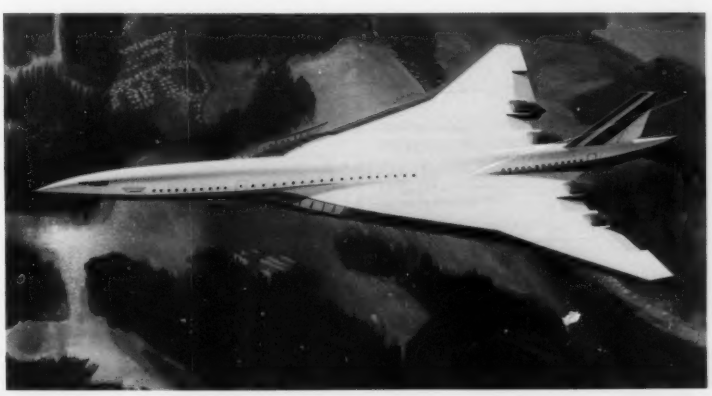


A Boeing conceptual design for a Mach 2.4 supersonic transport that would carry approximately 250 passengers 5,800 miles.

Conference Finds Global Biomass Burning Produces Significant Greenhouse Gases

Leading international scientists and environmental policy planners from more than 25 countries met in late March in Williamsburg, Virginia, to estimate how much of the Earth's surface burns each year and the amount of harmful gases produced. Also considered was the impact these gases have on the chemistry of the atmosphere, on climate and on the biosphere.

On an average day, thousands of acres of land are set afire. Such large-scale burning of the Earth's biological material damages ecosystems well beyond the immediate consequences of the fire. "When the smoke dissipates, the climatically dangerous greenhouse gases, produced by burning of forests, grasslands and vegetation, are just beginning their negative impact on our atmosphere," says Joel S. Levine, of NASA's Langley Research Center, leader of the first international scientific discussion on global biomass burning (GBB) and convener of the conference.

One of the most pressing questions the conference addressed is how biomass burning, ranging from the clearing of the Amazon rain forest to the worldwide burning of agricultural stubble, contributes to global change.

Major conference findings:

•Global biomass burning is a significant source of carbon dioxide and methane, both important greenhouse gases, as well as chemically active carbon monoxide and nitric oxide gases.

•Three to five billion metric tons of biomass carbon are burned annually compared to five to seven billion tons of fossil fuel carbon.

•Biomass burning produces about 40 percent of the carbon dioxide produced annually and 32 percent of all carbon monoxide produced.

•Very high levels of carbon monoxide were associated with biomass burning in south America and Africa, as measured on two Space Shuttle flights.

•Levels of ozone and acid rain in tropical Africa is approaching levels in industrialized countries. The African ozone level is so high it approaches levels toxic to plants.

•Biogenic emissions of nitrous oxide, nitric oxide and methane are significantly enhances after burning. Burn ash chemical compounds provide nutrients to microorganisms in the biogenic production of these gases.

"We believe that more than 95 percent of global burning is human initiated and can be stopped once the world's leaders are aware of its detrimental environmental consequences," Levine said. "This is one area of science where we can affect a reversal of a dangerous trend by raising awareness and public education. This is one of the goals of the Williamsburg conference."

The international conference was sponsored by the American Geophysical Union, Washington, D.C.; NASA Headquarters, Washington, D.C. and the Langley Research Center. Supporting the meeting were the National Science Foundation, the U.S. Environmental Protection Agency, the U.S. Forest Service, the international-Geosphere/Biosphere Global Change Project and the International Global Atmospheric Chemistry Project. ■

***High-Speed Transport,* from page 7**

sized to carry 250 passengers a distance of 5,800 statute miles.

Boeing considered an aircraft certification date of 2000, and assumed a 65 percent passenger load factor and a 50 percent flight-time savings. Using these standards, the company concluded that a Mach 2.4 transport could capture more than 50 percent of the long-haul international aircraft market, as many as 750 supersonic airliners.

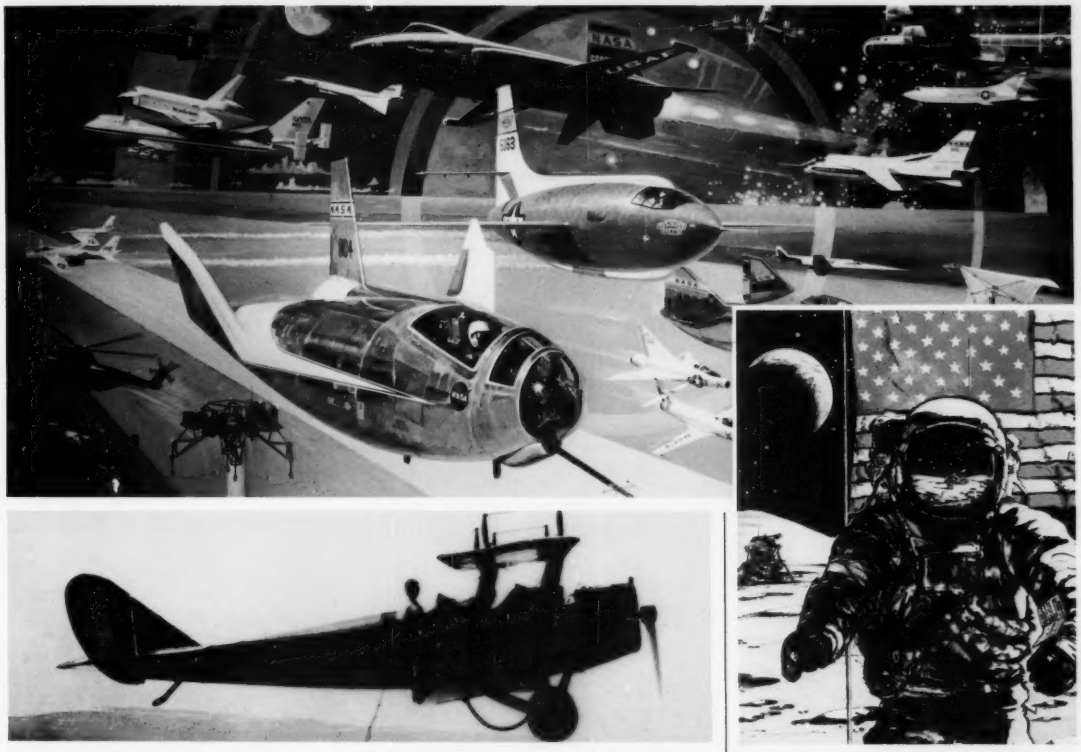
The same analysis indicates that a high-speed civil transport using current technology would snare only about one-third that amount of business, making capital investment far riskier. Furthermore, if two manufacturers competed for a share of today's supersonic market, economic viability would be even more reduced.

The study results have encouraged NASA, Boeing and Douglas to conduct additional research on a second-generation supersonic airliner. In 1989, NASA initiated the government-industry program to tackle the technical and economic challenges of making a high-speed civil transport an "environmental good neighbor." The effort will continue through the mid-1990's.

NASA officials caution that the High-Speed Research Program does not imply commitment to a supersonic civil transport aircraft. If the program shows sufficient promise and further studies confirm that such an aircraft is environmentally sound as well as important to the transportation system and the national economy, a cooperative NASA-industry focused vehicle technology development effort could be considered as a next step.

Ultimately, the decision to develop and produce a high-speed civil transport will rest with the nation's aerospace industry. ■

The 75th Anniversary for the First "A" in NASA



Art and science combines to express NACA/NASA achievements. The paintings are by Robert McCall; the 1922 flight test, by NACA Langley.

With just a $5,000 initial outlay 75 years ago, Congress established the National Advisory Committee for Aeronautics (NACA), which would in 1958 form the foundation for the National Aeronautics and Space Administration (NASA).

NACA was created to help regain the nation's position of aeronautical preeminence. Even today that first small investment — made only a dozen years after Orville Wright's famous flight — is still paying enormous dividends.

From its beginnings as a simple government entity, NACA grew into the world's premiere aeronautical research organization, pushing back the frontiers of flight for more than four decades. Aviation pioneers such as Orville Wright, Jimmy Doolittle, Charles Lindbergh and Eddie Rickenbacker were among the early NACA members.

Today, three-quarters of a century later, NASA scientists and engineers continue to solve the problems of flight, both in and beyond the Earth's atmosphere. But it was NACA that first built key facilities and devised organizational methods for advancing what is now called aerospace technology. The extent of the NACA-era legacy to NASA and the nation shines through in a recent celebration of engineering achievements by the National Academy of Engineering.

The Academy cited NASA's Apollo Moon landing as one of the greatest engineering achievements of all time and listed nine other achievements as the greatest of the past quarter-century. In addition to Apollo, three of these nine involve some large degree of NASA contribution: Unmanned satellites, advanced composite materials and the jumbo jet. Four other cited achievements fall within the sphere of daily activity throughout NASA: microprocessors, computer-aided design, lasers and fiber-optic communication.

Even after 75 years, that first $5,000 appropriated by Congress in 1915 is still paying off throughout the American economy and in NASA — a scientific and technological organization that spurs American competitiveness, spans the continent and reaches for the heavens. ■

ASTRO-1: Exploring the Invisible Universe with Ultraviolet and X-Ray Astronomy

As we gaze at the stars, the Universe sometimes seems too big and complicated to comprehend. We look to astronomers to contemplate concepts that extend our reach. Astronomers try to imagine the exquisite relationships of everything in the Universe.

Technology is the tool of their imaginations. For thousands of years, all their knowledge about the Universe came from visible light sensed with their eyes. Then, the telescope transformed astronomy, enabling observers to discover other galaxies, many consisting of hundreds of billions of stars. But even with our best visible light telescopes, we could not see a complete picture of the Universe. Visible light is a small part of the electromagnetic spectrum. Stars and other objects often emit more invisible radiation—radio waves, microwaves, infrared emission, ultraviolet emission, X-rays, and gamma rays—than visible light. From Earth, we can detect some radio and infrared wavelengths, but most radiation is absorbed by the atmosphere and never reaches telescopes on the ground.

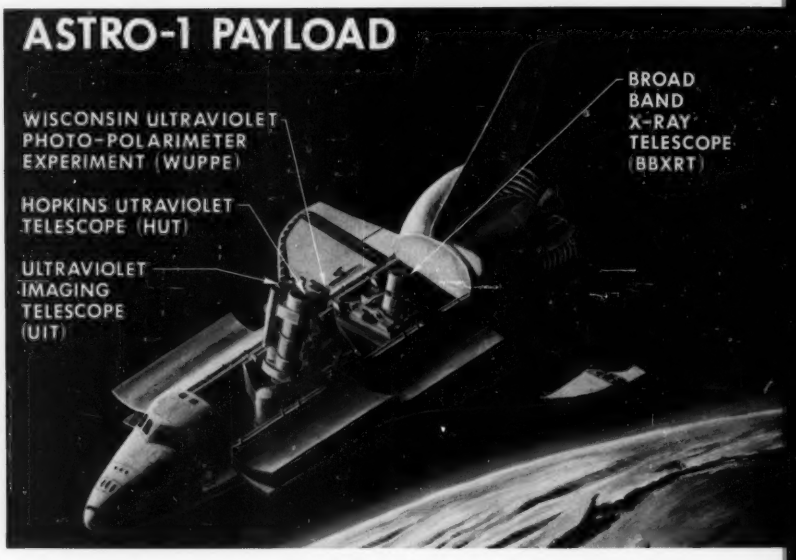
Each time we probe a new wavelength region, the Universe is found to be more vibrant and intricate than expected. The Universe is filled with motion and complex, evolving objects.

We are just beginning to explore the immense cosmic ocean, and there is much that we do not know. To learn more, we have to look deeper using new instruments and techniques.

To study invisible radiation from objects as thoroughly as we are studying their visible light, we need sensitive instruments in space. The National Aeronautics and Space Administration (NASA) has developed an observatory -Astro- that will detect ultraviolet and X-ray radiation from some of the most chaotic and fascinating objects in the Universe.

Astro will expose the hottest parts of galaxies: their active centers and dense globular clusters of stars shine with copious ultraviolet and X-ray emission. Quasars, perhaps the oldest and most energetic objects known, will be studied by Astro. The observatory may uncover objects that challenge our interpretation of the laws of physics: black holes that transform our concepts of space and time, and neutron stars so dense that a teaspoon of their material may weigh a billion tons.

Astro will chronicle the life cycles of stars. When they are born and when they die, stars emit large amounts of ultraviolet and X-ray radiation. To detect ultraviolet and X-ray radiation, Astro must be above the atmosphere. The Space Shuttle will carry Astro aloft for missions lasting from 9 to 11 days. Like an observatory on the ground, this new facility will be used by many scientists to answer questions about the Universe.


ASTRO-1 PAYLOAD
WISCONSIN ULTRAVIOLET PHOTO-POLARIMETER EXPERIMENT (WUPPE)
HOPKINS UTRAVIOLET TELESCOPE (HUT)
ULTRAVIOLET IMAGING TELESCOPE (UIT)
BROAD BAND X-RAY TELESCOPE (BBXRT)

The Astro Observatory

The Astro Observatory is a carefully selected set of telescopes and instruments uniquely designed to address specific questions in UV and X-ray astronomy, yet well-suited for joint observations. In fact, the advantage of using them together is the basis for the Astro Observatory.

The Astro Observatory has three UV-sensitive instruments: the Hopkins Ultraviolet Telescope (HUT) for studying spectra of faint

astronomical objects such as quasars, active galactic nuclei, and normal galaxies in the far ultraviolet; the Ultraviolet Imaging Telescope (UIT) for imaging objects such as hot stars and galaxies in broad ultraviolet wavelength bands and with a wide field of view; and the Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE) for studying the polarization of hot stars, galactic nuclei, and quasars. These instruments work together to make 200 to 300 observations during a typical mission.

The Astro ultraviolet telescopes are mounted on a pointing system that is attached to two Spacelab pallets, platforms carried in the payload bay of the Space Shuttle. The telescopes are coaligned so that they can be pointed in the same direction at the same time, thus increasing the scientific data return on every object that is observed.

A fourth Astro instrument, the Broad Band X-Ray Telescope (BBXRT), views high-energy objects: active galaxies, quasars, and is mounted on a separate pointing system secured by a support structure in the payload bay. For joint observations, it can be aligned with the UV telescopes to see the same objects, but it also can be pointed in other directions to view other X-ray sources. This instrument makes 200 to 300 observations per mission.

Unlike free-flying satellites that are launched and left in space, the Astro payload is designed to be reusable and may be reflown on additional Shuttle missions. Since the UV telescopes and the X-ray

continued on next page

The STS-35 Astro–1 Crew

(from l to r, 1st row)

Guy S. Gardner, Colonel, USAF, pilot. Gardner flew as pilot for the STS-27 mission launched December 2, 1988, a Department of Defense Mission, has served as a shuttle chase pilot and worked in several areas of shuttle development and support. A former instructor test pilot, he has logged over 3,900 flying hours.

Vance D. Brand, mission commander. Commanded STS-41B (launched Feb. 3, 1984) and STS-5 (launched Nov. 11, 1982), which orbited two communications satellites each. Brand served as Apollo command module pilot for the Apollo-Soyuz mission. He has logged 531 hours in space and more than 8,246 flying hours.

John M. "Mike" Lounge, mission specialist. Lounge served as a mission specialist on STS-51I (launched Aug. 27, 1985) which deployed AUSSAT, SYNCOM IV-4, and ASC-1 satellites and conducted on-orbit repair of the SYNCOM IV-3 satellite. He also served on STS-26, launching TDRS-C and has logged over 267 hours in space.

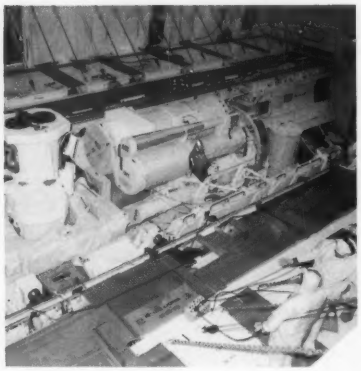
Robert A.R. Parker, Ph.D., mission specialist. Parker was a member of the support crews for Apollo 15 and 17 and served as program scientist for the three manned Skylab missions in the 1970s. On STS-9, the first Spacelab mission (launched Nov. 28, 1983), he performed astronomical and other experiments.

Ronald A. Parise, Ph.D., payload specialist. Parise is a senior scientist, Space Observatories department, Computer Sciences Corp. He has been involved in flight hardware development, electronic system design, and mission planning activities for the Ultraviolet Imaging Telescope project.

Jeffrey A. Hoffman, Ph.D., mission specialist. Hoffman served as a mission specialist on STS-51D (launched April 12, 1985) during which he made the first shuttle contingency spacewalk in an effort to rescue a malfunctioning satellite. His research interests are in the areas of cosmic gamma ray and x-ray astronomy.

Samuel T. Durrance, Ph.D., payload specialist. Durrance is a research scientist, Department of Physics and Astronomy, Johns Hopkins University and is assistant project scientist for the Hopkins Ultraviolet Telescope, participating in its design, construction, calibration and integration with the Astro observatory.

telescope are mounted on different support structures, they can be reflown together or separately. Prototypes of the instruments have been successfully tested and flown on sounding rockets. The first flight of these telescopes together makes Astro-1 a mission without precedent. The Astro Observatory can simultaneously obtain UV imagery, spectroscopy, and polarimetry data as well as X-ray spectroscopy on the same object. No other observatory has ever accomplished this feat.



The first Astro mission (Astro-1) will last 9 to 11 days and orbit Earth at an altitude of 354 kilometers (220 statute miles) at a 28.5 inclination to the equator. Kennedy Space Center in Florida is the launch site for Astro-1.

Preferred launch times for Astro missions result in long orbital nights and minimum passage through the South Atlantic Anomaly, a region of intense particle radiation that affects the detectors. While nighttime observations are preferred, the daytime portion of the orbit will be used to observe brighter celestial objects.

Astro-1 is the first Shuttle mission dedicated to a single scientific discipline: astrophysics. The ultraviolet telescopes are supported by Spacelab equipment. Spacelab is a set of modular components developed by the European Space Agency (ESA) and managed by the NASA/Marshall Space Flight Center (MSFC).

The X-ray telescope and the Three-Axis Pointing System (TAPS), developed at the NASA/Goddard Space Flight Center (GSFC), were designed for multiple missions. This payload will be anchored in a support structure placed just behind the UV telescopes in the Shuttle payload bay. BBXRT is attached directly to the TAPS inner gimbal frame.

The Payload Operations Control Center

The focus of the Astro mission is on activities aboard the Shuttle, yet a large group of scientists and engineers support the Shuttle and payload operations from the ground. Astro is blazing a new path in ground support operations. During past Shuttle flights, the science and engineering teams supporting instruments flown on Spacelab worked in the Payload Operations Control Center (POCC) located next to the Mission Control Center at Johnson Space Center (JSC). Astro-1 will be the first mission directed from a POCC located at Marshall Space Flight Center (MSFC) in Huntsville, Alabama.

The POCC is the nerve center for payload operations during an Astro mission. It is the site of communication between the crew, the mission support team, and the instrument teams. The mission manager and his team will conduct the missions from the MSFC POCC.

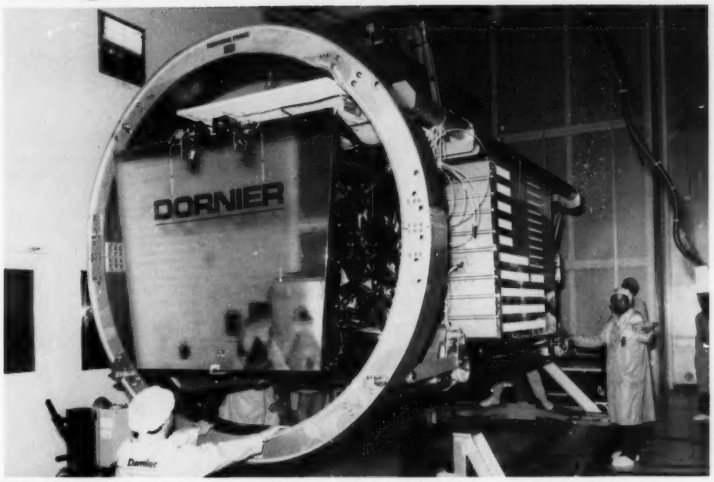
For this mission, a special team located at a remote POCC at the Goddard Space Flight Center (GSFC) in Greenbelt, Maryland, will operate the TAPS and BBXRT. However, some members of the BBXRT team will be stationed at the MSFC POCC to participate in science planning, and all commands issued to the payload will be coordinated with the mission management team at the MSFC POCC.

Both POCCs are staffed by teams of scientists and engineers who developed the Astro telescopes. ■

Members of the Spacelab Mission Operations Control team participate in a simulation of the Marshall Center-managed Astro-1 mission from Marshall's new Payload Operations Control Center.

CENTER HIGHLIGHTS

ROSAT Spacecraft Preparation Underway at KSC



The ROSAT scientific satellite at Kennedy Space Center upon its arrival from Germany.

Final assembly and pre-launch testing of the German ROSAT scientific satellite is underway in the clean room at NASA's Hangar AE, Cape Canaveral Air Force Station, Florida.

ROSAT, which stands for Roentgen Satellite, will be launched using a Delta II rocket, in late May or early June.

Built by Dornier Systems of the FRG, ROSAT will perform the first all-sky survey with an imaging x-ray telescope. The survey will be followed by individual observations of x-ray sources. ROSAT is a cooperative project between NASA and the FRG's Federal Ministry for Research and Technology. The United Kingdom is cooperating on ROSAT through an agreement with the FRG.

The spacecraft is equipped with two imaging telescopes—a German Large X-Ray Telescope and a smaller extreme ultraviolet telescope known as the Wide Field Camera, contributed by the United Kingdom. A High Resolution Imager (HRI) on the Large X-Ray Telescope, was contributed by the United States. The HRI was built by the Smithsonian Astrophysical Observatory and is managed by NASA's Goddard Space Flight Center, Greenbelt, Md.

After the initial 6-month all-sky survey, ROSAT will be devoted to detailed observations of x-ray sources with observing time divided among investigators from the United States, the FRG and the United Kingdom.

The 5,000-pound satellite will be deployed into a 53-degree inclined, circular orbit 360 miles from Earth. ROSAT will be launched from Complex 17 at Cape Canaveral Air Force Station by the U.S. Air Force and a McDonnell Douglas launch team.■

Scientists Advance Monitoring of Global Atmospheric Temps

An improved technique for potentially measuring global atmospheric temperature changes and possible global warming has been developed by scientists at NASA's Marshall Space Flight Center, Huntsville, Ala., and the University of Alabama in Huntsville (UAH).

Dr. Roy Spencer, a Marshall scientist in the Earth Science and Applications Division, and Dr. John Christy, a research scientist at UAH's Johnson Research Center, evaluated temperature data gathered by the National Oceanic and Atmospheric Administration (NOAA) satellites since 1979 to monitor monthly temperature variations over the globe to a mean accuracy of 0.01 degree Centigrade, setting a standard against which future temperature trends will be measured. While future global temperature variations were not specifically addressed, the decade from 1979-1988 showed no net warming or cooling trend.

The NOAA data had been used previously for localized weather forecasting, which involved only small portions of the data. By developing a 10-year data record with global coverage, Spencer and Christy have improved upon the surface thermometer network currently used to monitor global temperature.

Thermometers are largely restricted to populated areas, leaving the atmosphere over oceans essentially unmeasured. Earlier data used to support claims of global warming during the past 100 years have come from temperatures measured with these thermometers at the Earth's surface.

While monthly temperature variations measured by the satellites showed poor agreement with the surface thermometer data, annual

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Self-Repairing Flight Control System Demonstrated on F-15 at Ames-Dryden

By Don Haley, DFRF

NASA research pilots have successfully tested a flight control system that detects in-flight failures and automatically reconfigures an aircraft's ailerons, rudders and elevators, allowing pilots to continue their missions or land safely.

The self-repairing flight control system, first system of its type in the aerospace industry, has been demonstrated on NASA's F-15 Highly Integrated Digital Electronic Control research aircraft based at Ames-Dryden Flight Research Facility, Edwards, Calif.

The primary purpose of the system is to detect damaged flight control components and adjust undamaged flight surfaces so the pilot can maintain good aircraft response. When the system senses a failure, it selects the best precomputed solution from a set of control laws loaded into the F-15's computer. The system also can constantly monitor subsystems throughout the aircraft to diagnose and identify failures that are hard to repeat and isolate during postflight maintenance.

"This is a very significant and far reaching development in aviation," said James F. Stewart, project manager of the F-15 research program at Ames-Dryden. "Once it is fully developed and operational, the self-repairing flight control concept could greatly increase tactical aircraft survivability in combat and enhance safety during training missions. It also has the potential for adaptation to civil aircraft, enhancing aircraft and passenger safety."

On the initial self-repairing system demonstration flight, NASA research pilot James Smolka, flying at Mach 0.7, purposely locked the F-15's right horizontal stabilator to represent a failure of hydraulic or electronic systems. The self-repairing system instantly reconfigured the remaining stabilator, ailerons and rudder to establish aircraft pitch and roll control with the right stabilator remaining in the "failed" state.

A battle damage scenario in which control effectiveness of the right stabilator was changed to simulate flight with 80 percent of the span missing was then demonstrated. The system correctly identified the "damage" and reset

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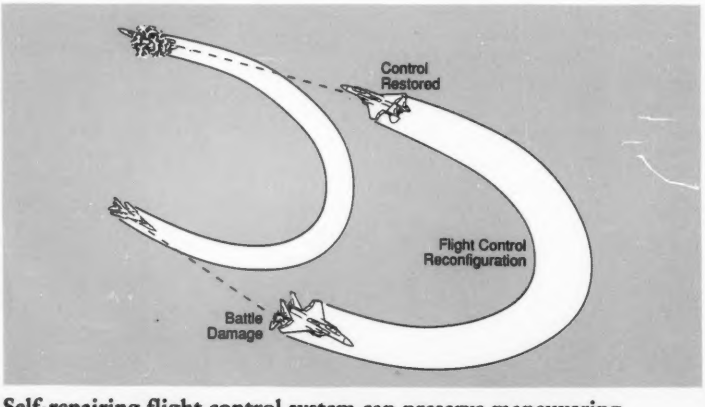
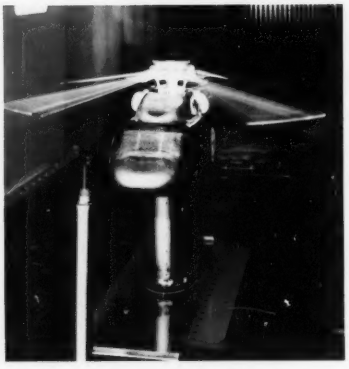


Self-repairing flight control system can preserve maneuvering capability of a damaged military aircraft.



HELICOPTER ON ICE — Lewis Research Center tests Sikorsky model helicopter in its icing research tunnel.

Lewis Conducts First U.S. Helicopter Icing Research

Tests were recently completed on a Sikorsky Powered Force Model in the NASA Lewis Research Center's Icing Research Tunnel. These tests were the first of their kind ever conducted in the United States.

The 1/6th scale helicopter model was tilted forward to simulate forward flight in an icing environment. Engineers expect to establish a new database on rotor performance degradation during icing, ice shedding characteristics and iced accretion shapes. This data will then be compared with computer code predictions to better understand the fundamentals of rotor icing.

The model was supplied by the Sikorsky Aircraft Division of United Technologies Corporation as a part of a program involving the four major U.S. helicopter manufacturers. Boeing Helicopters generated the recommended test plan; Bell Helicopter Textron and Texas A&M University prepared data acquisition systems; and McDonnell Douglas Helicopter Company fabricated the rotor blades. ■

LDEF Took A Licking But Kept on Ticking

By Les Dorr, Jr., NASA Hq

NASA officials and principal scientific investigators have finally taken their first close-up look at the Long Duration Exposure Facility (LDEF), a "treasure trove" of science and engineering experiments that spent nearly six years in orbit around Earth. For the most part, they like what they see.

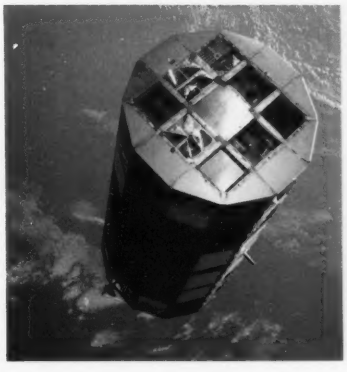
LDEF was snatched from space by the crew of Shuttle orbiter Columbia during the STS-32 mission in January.

Back on Earth, scientists and engineers observed LDEF from six feet to as close as a foot away, looking for any obvious effects of the satellite's prolonged exposure to the harsh environment of space. They found discolorations and other physical changes on many of LDEF's thermal control and optical surface experiments, and there seemed to be a significant contrast between the surfaces on the spacecraft's leading edge (facing the direction of flight) and those on the trailing edge. A possible explanation is that the experiments on LDEF's leading edge and in surrounding rows had a much higher exposure to the degrading effects of atomic oxygen.

Erosion Apparent

On solar array and structural materials, for example, unprotected Kapton thin-film insulation apparently eroded away. As a result, three solar cell modules and a number of 1-mil (1/1000 inch) polymer films on the Solar Array Materials Passive LDEF Experiment (SAMPLE) simply disappeared or floated off into space. Other Kapton films protected with silicon coatings, and silverized reflectors with ionic bonded solids, survived in much better shape.

Some of LDEF's scientific apparatus also took a beating during the satellite's prolonged stay in orbit. Many of the plastic films that covered capture cells on the Chemical and Isotopic Measurements of Micrometeoroids by Secondary Ion Mass Spectrometry experiment ruptured. Researchers weren't sure if their data would be compromised by the broken films, which were to catch material from



the vaporization of micrometeoroids upon impact. They hoped some sprays of vapor and debris were deposited inside the cells if the plastic was intact when impacts occurred.

Similarly, the thermal covers on seven of the eight Heavy Ions in Space modules partially detached and rolled up "like a sardine can," as Columbia's astronauts described the view when they observed the experiment in orbit. The loss of temperature control and exposure of the detectors to direct sunlight probably caused some data loss.

"Killer Tomatoes?"

And of course, thousands of students and teachers across America are awaiting their shipments of "killer tomatoes." The Space Exposed Experiment Developed for Students (SEEDS) was designed to determine the effect of space radiation on 12.5 million tomato seeds packaged aboard LDEF. After preliminary growth tests, the seeds will be sent to U.S. schools for classroom activities; it's the first time students have had the chance to do primary research on a space-borne investigation.

SEEDS was the first tray pulled from LDEF when technicians at Kennedy Space Center began to remove the spacecraft's experiments on February 23. Park Seed Company, which provided the tomato seeds, reported that a test batch seemed to be germinating normally early in March.

Results this Summer

As each of the 57 science and technology experiments is extracted from LDEF's framework, the Principal Investigators are taking a "quick-and-dirty" look before their devices are packed up and shipped to their home laboratories. This summer, the scientists and engineers who took part in the LDEF program will gather at Langley Research Center, where LDEF was built, to share their preliminary results. They expect that analysis of the experiments will provide invaluable data for the design of future structures, such as Space Station Freedom, that must endure lengthy stays in the space environment.

And what of the LDEF structure itself? Conceivably, new experiments could be developed and mounted aboard the satellite, and it could be reflown on a future Shuttle mission. It's more likely, however, that the LDEF framework will find a place of honor at Langley or another space exhibit center.

LDEF may end its days as a museum piece — but it will have had one heck of a story to tell. ■

NASA NEWS CAPSULES

News Capsules are NASA news releases edited by the Internal Communications Branch, Office of Communications.

NASA Acquires Triplesonic SR-71s on Loan From USAF

One of the three SR-71 reconnaissance aircraft being retired from operational service and loaned to NASA for a high-speed research program arrives at Ames-Dryden Flight Research Facility, Edwards, Calif.

Three supersonic SR-71 "Blackbird" aircraft, being retired from the U.S. Air Force, are slated for loan to NASA's Ames-Dryden Flight Research Facility, Edwards, Calif.

The aircraft will be in flyable storage at the NASA facility until the Air Force determines that it no longer has a need to preserve them. NASA officials currently are assessing research opportunities and experimentation that can benefit from using these high-speed flying testbeds.

The Dryden facility operated YF-12s, similar to SR-71s, from 1969 to 1979, gaining much useful research data on structures and stability and control of air-breathing aircraft at high speeds and altitudes.

The SR-71, manufactured by Lockheed Corp., is capable of flying at greater than three times the speed of sound. The aircraft's 101-foot long titanium structure is coated with a special black paint that helps dissipate heat caused by high speeds. ■

***Atmospheric Temperatures*, from page 13**

averages tended to agree more. Nothing could be said, however, about the validity of any long term warming trend observed by thermometers before 1979, due to the relatively short satellite data record.

The satellite data Christy and Spencer used came from microwave radiometers, developed by NASA, that each day measure the average temperature of the lowest 6 miles of the atmosphere over most of the Earth. ■

***Self-Repairing Flight Control System*, from page 14**

the other flying surfaces to restore normal controlled flight.

During self-repairing system activation, the pilot receives a preprogrammed visual warning on the cockpit heads up display that explains the type of system failure. This alert readout gives the pilot new flight limits such as reduced speed or maneuvering loads that the failure or battle damage may impose.

The maintenance diagnostic capability of the self-repairing system was demonstrated by five types of failures programmed into the F-15 research aircraft's flight computer. Each was selectable by the pilot and set to activate only under specified maneuver conditions. The system was able to identify all five intermittent electrical, mechanical and hydraulic faults. After the F-15 aircraft returned to Ames-Dryden, the failure data and appropriate repair instructions were displayed on a ground station screen that would have facilitated repair work to return the plane to 100 percent flight status.

An advanced self-repairing system is expected to be developed and thoroughly tested before the technology is used in future aircraft designs or retrofitted on existing aircraft. The operational envelope of such an advanced system may include landing tasks, supersonic speeds and flight in automatic terrain-avoidance and terrain-following modes.

Besides James Smolka, other NASA pilots taking part in the system development have been Tom McMurtry, chief of Ames-Dryden's Aircraft Operations Division and Ames-Dryden chief test pilot Bill Dana.

McDonnell Aircraft Co., St. Louis, and General Electric's Aircraft Control Division, Binghamton, N.Y., developed the self repairing system under contract to NASA's Ames-Dryden facility. The U.S. Air Force Wright Research and Development Center, Wright-Patterson AFB, Ohio, sponsors the program. ■

NASA STORY

Snoopy in Space

By Lee Saegesser, NASA Hq

SNOOPY	"Hello, Charlie Brown, Snoop."
CHARLIE BROWN	"Go ahead, over."
CAPCOM	"Snoopy - Charlie - this is Houston."
CAPCOM	"Good readback, Snoop. Over."
SNOOPY	"Houston, this is Snoop. Charlie Brown's trying to call you."

Sound like something out of a Peanuts comic strip? This conversation actually took place in space, while the Apollo 10 crew was circling the moon in May 1969.

How did Snoopy come to be in space? To understand his association with NASA it is necessary to go back to the early 1960s.

The Mercury program was nearing completion in 1963. It had proved that man could survive in space and perform useful functions while in orbit. The Manned Flight Awareness Program had its beginnings at a meeting of the Office of Space Flight Management Council January 29, 1963 at Cape Canaveral, Florida. During this meeting NASA's top managers decided that all NASA Centers engaged in manned flight programs should initiate an awareness program to impress program participants of the importance of careful work, meticulous quality control, and depth of design consideration. This would apply not only to management but also to engineering, center workforce, contractor and subcontractor personnel. As the concept of manned flight awareness developed, it spread to many of the aerospace companies supplying hardware and services for NASA's spacecraft and launch vehicles.

Manned Flight Awareness

A March 1968 study of existing industry motivational programs with emphasis on flight safety, identified methods of allowing workers to identify with flight crews and their missions.

NASA wanted a symbol already accepted by the public and particularly suitable to those working on manned flight systems. A major aspect of the Manned Flight Awareness Program was astronaut visits and the associated recognition by them of deserving employees. In 1968 Snoopy, the precocious puppy from the Peanuts comic strip by Charles M. Schulz appeared to be just what was needed. The astronauts approached Mr. Schulz, who was an enthusiastic supporter of the space program, to obtain his permission to use Snoopy. He quickly granted permission. And thus began a long association of Snoopy with the astronauts as their personal symbol for professional excellence. Deserving employees receive a personal letter from an astronaut and a silver lapel pin depicting Snoopy in a space suit. In most cases the award is personally presented by an astronaut.

Snoopy Flies to Moon

This brings us to Snoopy's 1969 voyage to the moon. The Apollo 10 mission was launched by a Saturn 5 rocket from the Kennedy Space Center, Florida on May 18. Sitting high atop the massive launch vehicle were the command module code named "Charlie Brown" and the lunar module with the call sign "Snoopy."

This mission was a dress rehearsal for the historic lunar landing of Apollo 11 to follow in two months.

The crew of Apollo 10, Thomas P. Stafford, John W. Young, and Eugene A. Cernan, rode these spacecraft in their eight-day space odyssey. Asked at a pre-flight news conference why the lunar module was named Snoopy, flight commander Stafford replied, "Since we're going to the moon to find out all these facts and kind of snoop around, the lunar module's going to be called Snoopy."

Apollo 10 did everything that Apollo 11 was to do, except land on the moon. On May 22 Snoopy separated from Charlie Brown and began its powered descent to within 8.4 nautical miles of the lunar surface. Skimming over the Sea of Tranquility, Cernan excitedly commented, "Hello Houston, we is down among it!," meaning the two-man crew of the lunar module were almost touching the peaks of the moon.

A few hours later Snoopy redocked with Charlie Brown after having completed its reconnaissance of the Apollo 11 landing site. When Houston Mission Control learned of the successful docking, they broke out a large cartoon showing Snoopy kissing Charlie Brown. The accompanying balloon read, "Smack. You're right on target, Charlie Brown." Commenting on the workmanship of the spacecraft, one of the astronauts said, "... there is a lot of people who did a good [job], and I'll tell you these vehicles, so far, that little Snoopy was a real winner. And big Charlie Brown is no slouch either."

After the astronauts transferred from the lunar module to the command module and no longer needed the vehicle, Snoopy was cast loose. Shortly afterward, its engine was fired which drove it into an orbit around the sun. Today Snoopy is silently orbiting the sun as another reminder of the dedication of this little beagle and its namesake.

Snoopy has been used through the years in many patches and emblems associated with the Manned Flight Awareness Program. Apollo, Skylab, Apollo-Soyuz, and Space Transportation System (Space Shuttle), and the upcoming Space Station Freedom have or will have symbols incorporating Snoopy and safety into the design.

Snoopy has always promoted excellence and safety in space flight. The dauntless puppy is featured prominently on Manned Space Flight Awareness posters distributed throughout NASA and its contractors. The little beagle is a meaningful link between the astronauts and members of the NASA-industry work team. The light-hearted and lively character of Snoopy brings a needed lightness to the space program.

Thank you Snoopy!

BIOGRAPHY

SAM PHILLIPS:

One who led us to the moon.

By Sarah H. Turner, NASA Hq

It was Sam Phillips' military career that first involved him in aerospace. During World War II he served in England as a fighter pilot with the Eighth Air Force from 1944 to 1945 but soon after he pursued a Masters degree in electrical engineering and then he specialized in research and development in the service's Air Material Command at Wright Patterson AFB, Ohio. Six years later he returned to England as Chief of Logistics in the Strategic Air Command's 7th Air Division and participated in writing the international agreement with Great Britain on the use of the Thor Intermediate Range Ballistic Missile (IRBM).

In 1959 he was assigned to manage the development of the Minuteman ICBM Program.

The Minuteman Program posed some unique problems for the Air Force. The program called for the development of new technology and equipment for the missile system and to achieve large-scale production in a relatively short time. Phillips' plan gave total control to the Program Director and Program Office and stressed teamwork.

It was the success of the Minuteman Program that brought him to the attention of NASA. In 1963 he was appointed Deputy Director of the Apollo Program and Phillips brought to NASA the skills needed to carry out a large and complex program. At its peak, the Apollo Program employed over 300,000 people who worked for the 35 major contractors, 4,000 prime subcontractors, and various government, scientific and academic organizations.

By 1964, Phillips had been promoted to Director of the Apollo Program. Alerted in 1966 to problems with engineering, scheduling, and quality control for the Saturn II second stage and the Apollo Command and Service Module (CSM), Phillips and a group of analysts surveyed the problems and recommended changes in engineering and management at North American and its prime subcontractor on the CSM, AirResearch.

His concern proved to be prophetic, for less than a year later the Apollo 204 CSM caught fire during a countdown simulation and killed astronauts Gus Grissom, Ed White, and Roger Chaffee. During the investigation the Review Board identified many of the same problems that Phillips had recommended for change as factors that contributed to the fire. Phillips was later quoted as saying, "The Apollo fire cost us a year in time, six months to make all the changes we had to make, and six months to explain them all to Congress." The tragedy provided the opportunity to revamp the program and make administrative changes within NASA and North American

continued on page 19

HUMAN FACTORS

JPL Chief, Dr. Lew Allen Awarded Goddard Trophy

Vice President Dan Quayle presented the Dr. Robert H. Goddard Memorial Trophy to the 1990 winner, Dr. Lew Allen, in ceremonies at the White House recently. Allen is Director of the NASA Jet Propulsion Laboratory, Pasadena, Calif. and Vice President of the California Institute of Technology.

Dr. Allen received the 1990 award "For distinguished and significant contributions to the Nation's advancement in space, earlier by service with the Air Force and the strategic defense of the country, and currently by leadership with NASA in the assurance of United States preeminence in planetary exploration."

The Goddard Trophy, premier award of the National Space Club and the aerospace industry, was established in 1958. ■

Peterson Named Deputy Director at Ames

Dr. Dale L. Compton, Director of NASA's Ames Research Center, Mountain View, Calif., has named Victor L. Peterson, Deputy Director of the Center.

Peterson served as Ames' Director of Aerophysics from 1984 and as the Center's Acting Deputy Director since 1988. He has held various positions at Ames, including Research Scientist, Chief of the Aerodynamics Branch and Chief of the Thermo and Gas Dynamics Division. He was one of the originators of the NASA initiative to develop the Numerical Aerodynamic Simulation System, the leading computational resource for the nation's aerospace program.

Peterson joined Ames in 1956 after receiving a bachelor's degree in aeronautical engineering from Oregon State University. He also holds a master's degree in aeronautics and astronautics sciences from Stanford University and a master's degree in management from the Massachusetts Institute of Technology, where he was an Alfred P. Sloan Fellow. ■

***Sam Phillips*, from page 18**

Aviation.

Problems with the Grumman Aircraft Corporation Lunar Module (LM) led to the idea to use the Apollo 8 mission as a circumlunar flight. The plan went by the code name "Sam's Budget Exercise," prior to being divulged to top officials.

The successful flights of Apollo 7, 8, 9, and 10 led to the Apollo 11 lunar landing. It was after the Apollo 10 mission that Phillips told his wife, "I hope I have enough strength for Number 11." He did, and two months later man landed on the moon. Of that feat he said, "The men and equipment that are Apollo 11 have performed to perfection. Perfection is not too strong a word." During the Apollo 11 mission Phillips announced his decision to return to the Air Force, remarking "Ten years in the hot seat [Minuteman and Apollo] is too long."

Some of the names and faces of the Apollo era will be remembered for a long time—VonBraun, Armstrong, Aldrin, and Collins. But very few people remember the name of the man that Wernher Von Braun held responsible for the success of the Apollo program — Samuel C. Phillips, the program's Director.

Upon leaving NASA he took command of the Air Force Space and Missile Organization (SAMSO) and was named Director of the National Security Agency (NSA) in 1972.

Phillips left the NSA in 1973 to become commander of the Air Force Strategic Air Command and retired two years later. He joined TRW as general manager of its Energy Systems Management Division and became Vice President of TRW's Defense Systems Group in 1984.

Phillips retired from TRW in 1986 only to return to NASA in the wake of the Challenger Accident. He was chosen to head up a NASA management study co-sponsored by the National Academy of Public Administration. Among several things, it recommended strong headquarters direction for all programs, combining the space shuttle and space station programs and instituting formal planning for long range goals. The report was well received by NASA and the agency implemented the recommendations. In 1988, the study group led by Phillips updated the report and recommended only incremental improvement against a record of steady progress.

Sam Phillips died on January 31, 1990 at his home in California. He was 68 years old. ■

ANOTHER DIVIDEND FROM AIR & SPACE

KSC Offers Air Pack Technology To Manufacturers

Representatives from fire-fighting equipment manufacturers and fire departments throughout the country visited Kennedy Space Center recently to learn how a KSC-developed self-contained air breathing apparatus (SCBA) system could be turned into a commercial product that offers more breathing time with less weight than hardware now on the market.

"This is a technology that we are transferring from Kennedy Space Center to the firefighting community," Tom Hammond, KSC Technology Utilization Officer, told conference participants. "Our intention is to help industry modify our system through a cost-share project so that it can be used by fire departments throughout the country." Bill Rock, director of the NASA Advanced Projects, Technology and Commercialization Office at KSC, explained how the new air supply system evolved out of a need to protect KSC workers from hazardous materials used in processing the Space Shuttle for launch. He also pointed out that the transfer of such space program technology to industry is a two-way street, with NASA getting back much of the technology once it has been commercialized.

The SCBA is a liquid air pack used by EG&G Florida fire and rescue crews. These crews would enter the Space Shuttle orbiter crew cabin to rescue astronauts in case of a launch pad emergency. Lockheed Space Operations Company White Room closeout crews also employ this breathing equipment during final prelaunch preparations.

EG&G Florida personnel designed, developed and built the packs solely for use at KSC, with guidance from NASA and technology from the space program.

The air packs get a real-world test in KSC's Space Shuttle Mate-Demate Device.

NASA considers a liquid air system the most efficient way to provide a sufficient air supply for rescue team members.

Unlike most conventional, long-duration firefighter breathing equipment, the liquid air pack is designed to fit through the narrow hatches and passageways inside the orbiter. It also is lighter than commercial air supply systems, and in tests conducted by the KSC Biomedical Engineering Office has been shown to supply the user with more than an hour's worth of a pure, cool mix of nitrogen and oxygen under strenuous work conditions. The standard air pack now being used by most fire departments is rated for 30 minutes breathing time.

However, when subjected to the same conditions that the KSC system was, this unit operated for only 17 minutes.

After presenting the data at the conference to support these conclusions, Don Doerr, chief of the Biomedical Engineering Office, and Dr.Vic Convertino, NASA research physiologist, demonstrated how the findings translated to real world conditions.

With Doerr wearing the standard 30-minute air pack and Convertino donning the KSC liquid air pack, both men repeatedly climbed the stairs of the 105-foot orbiter transfer tower and performed a side-by-side carry of a 120-pound trunk up and down a small hill. Both of these activities simulated those that firefighters could experience while battling a blaze in a high-rise office building, Doerr said.

The demonstration ended abruptly after 22 minutes when Doerr's portable backpack unit gave a loud whistle, the audible warning that he was running out of air. Meanwhile, Convertino's unit still had four of its six pounds of liquid air left. This was enough to supply considerably more breathing time, Doerr said. "We have downrated our system to 45 minutes, even though according to National Institute for Occupational Safety and Health (NIOSH) standards, 6 pounds of air is sufficient enough for one hour," Doerr pointed out. "The KSC system will supply air for at least that long no matter how strenuous the physical activity."

"We believe that the liquid air pack can provide 2 to 6 times more breathing time than firefighting equipment in use today," Hammond said." ■